MACQUARIE University
BUSINESS SCHOOL
SYDNEY·AUSTRALIA

ACST1001 Finance Fundamentals

WEEK 3: TOOLS FOR FINANCIAL DECISION-MAKING: TIME VALUE OF MONEY 1

Week 3 learning outcomes

1. Identify the role of competitive markets in decision-making.
2. Understand the Valuation Principle and how it can be used to identify decisions that increase wealth.
3. Assess the effect of interest rates on today's value of future cash flows.
4. Calculate the future value and present value of a single cash flow.
5. Use Excel to calculate the future value and present value of a single cash flow.

Week 3 lecture outline

1. Valuing decisions
2. Market prices and valuation principle
3. The time value of money and interest rates
4. Valuing cash flows at different points in time
5. Excel TVM functions

1. Valuing decisions

INTRODUCTION

In 2023, Tesla decided to begin production of the much-anticipated Cybertruck, expanding its product suite beyond sedans and entering a new market segment. How did Tesla's managers decide that this was the right decision for the company?

Source: https://www.whichcar.com.au/reviews/2024-tesla-cybertruck-review-first-international-drive

1. Valuing decisions

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INTRODUCTION

The goal of finance is to maximise wealth (also called value) by making optimal financial decisions.

For financial decisions:

1. We need to identify the relevant costs and benefits of the decision.
2. Since costs and benefits may occur at different points in time or in different currencies, they must be converted to a common unit, such as dollars today.
3. Once converted to a common unit, an optimal financial decision is one where the benefits exceed the costs.

In this lecture, we learn (1) how to use market information to evaluate costs and benefits and (2) why market prices are so important. Then, we will start to build critical tools relating to the time value of money. These tools will allow you to compare the costs and benefits of a decision correctly, no matter when they occur.

1. Valuing decisions

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IDENTIFYING COSTS AND BENEFITS

A firm's financial manager makes decisions on behalf of the firm's investors (benefits exceeding costs, which will increase the firm's value).

Real-world opportunities are often difficult to quantify and involve using skills from other management disciplines:

- Marketing (increasing revenue from advertising)
- Economics (impact on demand from lowering the price)
- Organisational behaviour (change in management structure on productivity)
- Strategy (competitors' response to your price drop)
- Operations (production costs after upgrading your plant)

1. Valuing decisions

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QUANTIFYING COSTS AND BENEFITS

Suppose a jewellery manufacturer has the opportunity to trade 400 ounces of silver for 5 ounces of gold today. Suppose silver is priced at $20 an ounce and gold is priced at $2,000.

To compare the costs and benefits, we first need to convert them to a common unit.

- 400 ounces of silver we **give up** has a cash value of: $400 \text{ ounces of silver} \times \$20/\text{ounce} = \$8{,}000$
- 5 ounces of gold we **receive** has a cash value of: $5 \text{ ounces of gold} \times \$20/\text{ounce} = \$10{,}000$

1. Valuing decisions

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QUANTIFYING COSTS AND BENEFITS

Based on the above, the jeweller's opportunity has a benefit of $10,000 today and a cost of $8,000 today. Therefore, the net value of the project today is:

$$\$10{,}000 - \$8{,}000 = \$2{,}000$$

The net value is positive because the benefits exceed the cost. Therefore, the jeweller should accept the trade as it will increase her wealth.

1. Valuing decisions

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THE ROLE OF COMPETITIVE MARKET PRICES

Competitive market:

- A competitive market is one in which a good can be bought and sold at the same price.
- In a competitive market, the price determines the value of the good.

In evaluating the jeweller's decision, we used the current market price to convert from ounces of silver or gold to dollars.

We did not concern ourselves with whether the jeweller thought that the price was fair or whether the jeweller would use the silver or gold. Why?

2. Market prices and the valuation principle

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THE VALUATION PRINCIPLE

- The **valuation principle** is based on the notion that the benefits of a decision in terms of cash flows exceed the value of its costs.
  - This is the basis for decision-making throughout this unit.
- The value of a commodity or an asset to the firm or its investors is determined by its competitive market price.
- The benefits and costs of a decision should be evaluated using those market prices.
- When the value of the benefits exceeds the value of the costs, the decision will increase wealth.

2. Market prices and the valuation principle

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APPLYING THE VALUATION PRINCIPLE

You are the operations manager at your firm. Due to a pre-existing contract, you have the opportunity to acquire 200 barrels of oil and 3,000 kg of copper for a total of $25,000.

The current market price of oil is $90 per barrel, and copper is $3.50 per kg.

You are not sure that you need all of the oil and copper, so you are wondering if you should take this opportunity.

- How valuable is it?
- Would your decision change if you believed the value of oil or copper would decrease significantly over the next month?

2. Market prices and the valuation principle

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APPLYING THE VALUATION PRINCIPLE

We need to quantify the costs and benefits using market prices. We are comparing $25,000 with:

- 200 barrels of oil at $90 per barrel
- 3,000 kg of copper at $3.50 per kg

Using the competitive market prices, we have:

- $200 \text{ barrels of oil} \times \$90/\text{barrel today} = \$18{,}000 \text{ today}$
- $3{,}000 \text{ kg of copper} \times \$3.50/\text{kg today} = \$10{,}500 \text{ today}$

The value of the opportunity is the value of the oil plus the value of the copper less the cost of the opportunity, or $18,000 + $10,500 - $25,000 = $3,500 today. Because the value is positive, we should take it.

2. Market prices and the valuation principle

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APPLYING THE VALUATION PRINCIPLE

Since we are transacting today, only the current prices in a competitive market matter.

Our own use for, or opinion about the future prospects of oil or copper do not alter the value of the decision today.

This decision is good for the firm and will increase its value by $3,500.

3. The time value of money and interest rates

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THE TIME VALUE OF MONEY

Consider an investment opportunity with the following cash flows

- **Cost:** $100,000 today
- **Benefit:** $105,000 in one year

The difference in value between money today and money in the future is due to the **time value of money**.

Calculating the net value as $\$105{,}000 - \$100{,}000 = \$5{,}000$ is incorrect because it ignores the time value of money.

3. The time value of money and interest rates

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THE INTEREST RATE: CONVERTING CASH ACROSS TIME

By depositing money, we convert money today into money in the future.

By borrowing money, we exchange money today for money in the future.

The **interest rate** (r) is the rate at which money can be borrowed or lent over a given period.

The **interest rate factor** $(1 + r)$ is the rate of exchange between dollars today and dollars in the future.

- It has units of '$ in one year / $ today'.

3. The time value of money and interest rates

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THE INTEREST RATE: CONVERTING CASH ACROSS TIME

Discount factors and rates: Money in the future is worth less today, so its price reflects a discount.

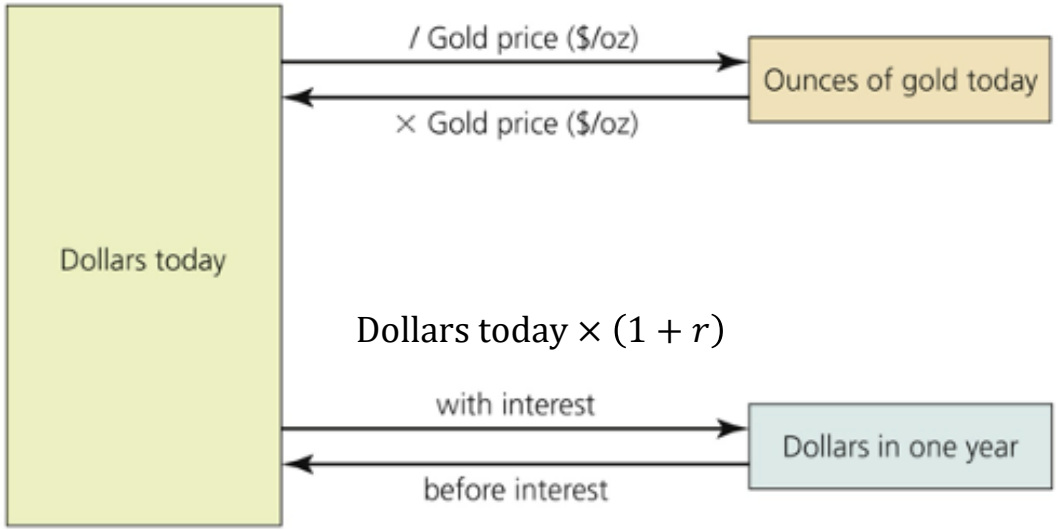
- The interest rate (r) is also known as the discount rate.
- This is the appropriate rate to discount a cash flow to determine its value at an earlier time.
- The discount factor is the value today of a dollar received in the future, expressed as: $\frac{1}{(1+r)}$.

3. The time value of money and interest rates

THE INTEREST RATE: CONVERTING CASH ACROSS TIME

We can convert dollars today to different goods or points in time by using the competitive market price or interest rate.

Once values are in equivalent terms, we can use the Valuation Principle to make a decision.



Source: Berk et. al., Fundamentals of Corporate Finance 4th edition

3. The time value of money and interest rates

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THE INTEREST RATE: CONVERTING CASH ACROSS TIME

The value of the $100,000 investment in *one year*:

If the interest is 10% per year, then we can express our costs as:

$$\text{Cost} = \$100{,}000 \text{ today} \times (1 + 0.10) = \$100{,}000 \text{ today} \times 1.10 = \$110{,}000 \text{ in one year}$$

Both costs and benefits are now in "dollars in one year", so we can compare them and calculate the investment's net value in one year:

$$\text{Net value} = \$105{,}000 - \$110{,}000 = -\$5{,}000 \text{ in one year}$$

In other words, we could earn $5,000 more in one year by depositing our $100,000 in the bank at an interest rate of 10% per year rather than making this investment. We should, therefore, reject this investment.

3. The time value of money and interest rates

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THE INTEREST RATE: CONVERTING CASH ACROSS TIME

The value of the $100,000 investment *today*:

Consider the benefit of $105,000 in one year. What is the equivalent amount in terms of dollars today?

$$\text{Benefit} = \frac{\$105{,}000 \text{ in one year}}{(1 + 0.10)} = \frac{\$105{,}000 \text{ in one year}}{1.10} = \$95{,}454.55 \text{ today}$$

This is the amount the bank would lend to us today if we promised to repay $105,000 in one year.

3. The time value of money and interest rates

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THE INTEREST RATE: CONVERTING CASH ACROSS TIME

The investment's net value **today** is the difference between the cost of the investment and the benefit:

$$\$95{,}454.55 - \$100{,}000 = -\$4{,}545.55 \text{ today}$$

Once again, the negative result indicates that we should reject the investment.

Why? Taking the investment would make you poorer by $4,545.55 today because you gave up $100,000 for something worth only $95,454.55.

Note that because this net value is calculated in dollars today (in the present), it is typically called the **net present value**.

3. The time value of money and interest rates

This demonstrates that our decision is the same whether we express the value of the investment in terms of dollars in one year or dollars today.

If we convert from dollars today to dollars in one year: $-\$4{,}545.55\ \text{today} \times 1.10 = -\$5{,}000\ \text{in one year}$, the two results are equivalent but expressed as values at different points in time.

When we express the value in terms of dollars today, we call it the **present value (PV)** of the investment.

If we express it in terms of dollars in the future, we call it the **future value (FV)** of the investment.

3. The time value of money and interest rates

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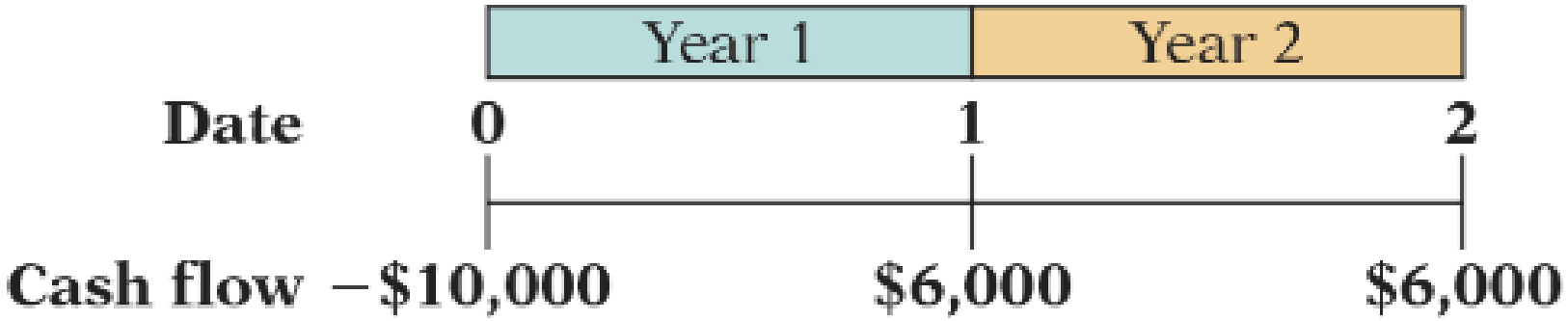
TIMELINES

- A timeline is a linear representation of the timing of potential cash flows.
- Drawing a timeline will help you visualise a financial problem.
- Timelines can represent cash flows that take place at the **beginning or end of any time period** (years, months, etc.).
- Identifying dates on a timeline: Date 0 is today, the beginning of the first year; Date 1 is the end of the first year.
- Distinguishing between cash inflows and cash outflows.
  - Inflows are positive cash flows.
  - Outflows are negative cash flows, which are indicated with a −(minus) sign

3. The time value of money and interest rates

TIMELINES

- Assume that you are lending $10,000 today and will be repaid the loan in two annual $6,000 amounts.



- The first cash flow at date 0 (today) is represented as a negative number because it is an outflow

4. Valuing cash flows at different points in time

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THE THREE RULES OF TIME TRAVEL

Financial decisions often require combining cash flows or comparing values. Three rules govern these processes.

Rule 1	Only values at the same point in time can be compared or combined.	
Rule 2	To move a cash flow forward in time, you must compound it.	Future value of a cash flow $FV_n = C \times (1+r)^n$
Rule 3	To move a cash flow backward in time, you must discount it.	Present value of a cash flow $PV = C \div (1+r)^n = \frac{C}{(1+r)^n}$

4. Valuing cash flows at different points in time

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THE THREE RULES OF TIME TRAVEL: RULE 1 COMPARING AND COMBINING VALUES

A dollar today and a dollar in one year are not equivalent.

It is only possible to compare or combine values at the same point in time.

- Which would you prefer: A gift of $1,000 today or $1,210 at a later date?
- To answer this, you will have to compare the alternatives to decide which is worth more.
- One factor to consider: How long is “later?”

4. Valuing cash flows at different points in time

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THE THREE RULES OF TIME TRAVEL: RULE 2 COMPOUNDING

To move a cash flow forward in time, you must **compound** it.

Suppose you have a choice between receiving $1,000 today or $1,210 in two years

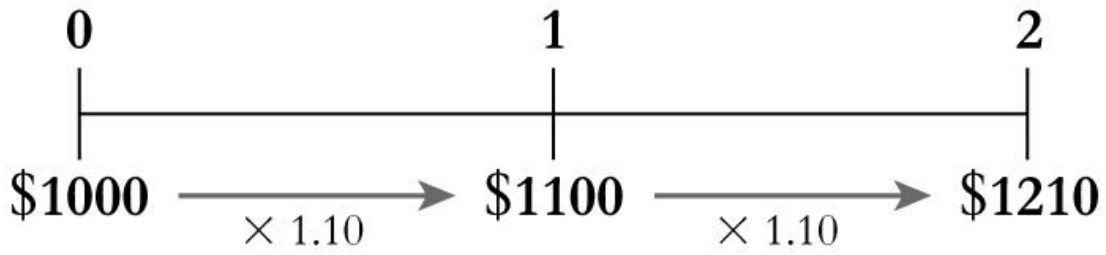
- You believe you can earn 10% per year on the $1,000 today but want to know what the $1,000 will be worth in two years

The value in one year is: $\$1{,}000 \times 1.10 = \$1{,}100$.

The value in two years is: $\$1{,}100 \times 1.10 = \$1{,}210$.

4. Valuing cash flows at different points in time

THE THREE RULES OF TIME TRAVEL: RULE 2 COMPOUNDING



Observations:

- The value grows as we move the cash flow further into the future.
- The equivalent amount grows by $100 in the first year but by $110 in the second year.
  - In the second year we earn interest on our original $1,000, plus we earn interest on the $100 interest we received in the first year.
  - This effect of earning interest on both the original principal plus the accumulated interest, so that you are earning 'interest on interest', is known as **compound** interest.

4. Valuing cash flows at different points in time

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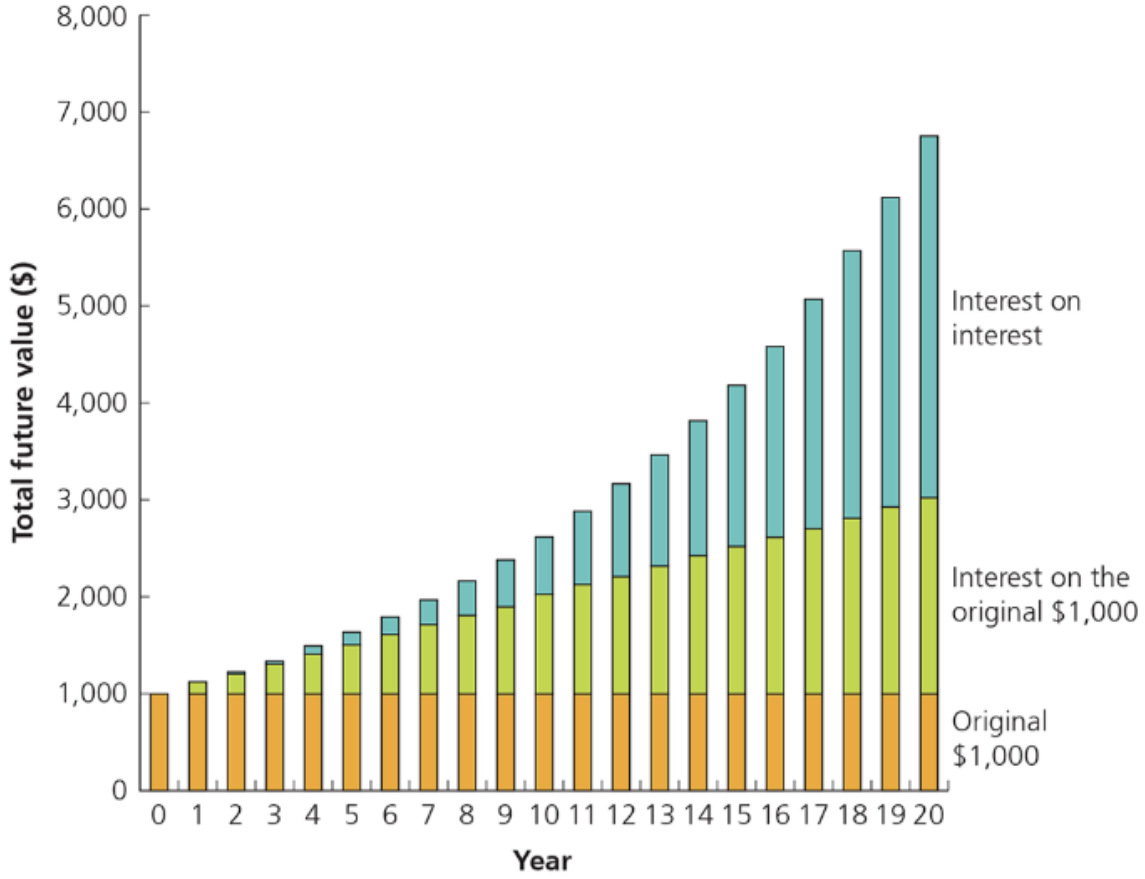
THE THREE RULES OF TIME TRAVEL: RULE 2 COMPOUNDING

By year 20, the future value is $6,727.50, which is comprised of:

- The original $1,000 deposit.
- Interest earned on the original $1,000 deposit of $20 \times \$100 = \$2{,}000$.
- Interest on interest of $3,727.50.



Source: Berk et. al., Fundamentals of Corporate Finance 4th edition

4. Valuing cash flows at different points in time

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THE THREE RULES OF TIME TRAVEL: RULE 2 COMPOUNDING

What is the future value in the third year?

$$\$1{,}000 \times 1.10 \times 1.10 \times 1.10 = \$1{,}000 \times 1.10^3 = \$1{,}331$$

In general, to compute a cash flow *C*'s value *n* periods into the future, we must compound it by the *n* intervening interest rate factors. If the per period interest rate *r* is constant, this calculation yields:

$$FV_n = C \times (1 + r) \times (1 + r) \ldots \times (1 + r) = C \times (1 + r)^n$$

4. Valuing cash flows at different points in time

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LECTURE EXAMPLE 1: PROBLEM

Suppose you have a choice between receiving $5,000 today or $10,000 in five years. You believe you can earn 10% per year on the $5,000 today but want to know what the $5,000 will be worth in five years. Which alternative do you prefer?

4. Valuing cash flows at different points in time

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LECTURE EXAMPLE 1: SOLUTION

In five years, the $5,000 will grow to a future value of:

$$\$5{,}000 \times 1.10^5 = \$8{,}052.55$$

You would be better off forgoing the gift of $5,000 today and taking the $10,000 in five years.

4. Valuing cash flows at different points in time

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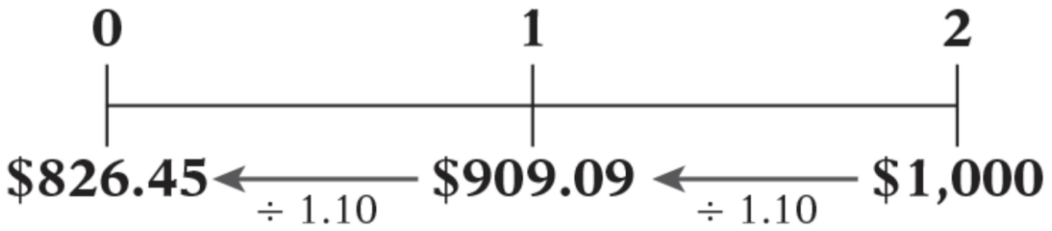
THE THREE RULES OF TIME TRAVEL: RULE 3 DISCOUNTING

To move a cash flow backward in time, you must **discount** it.

Suppose you anticipate receiving $1,000 two years from today. If the interest rate for both years is 10% per year, you can prepare the following timeline:



Observations:

- When the interest rate is 10% per year, all of the above values are equivalent. They represent the same value in different units (different points in time).
- The value decreases as the original cash flow moves further into the future.

4. Valuing cash flows at different points in time

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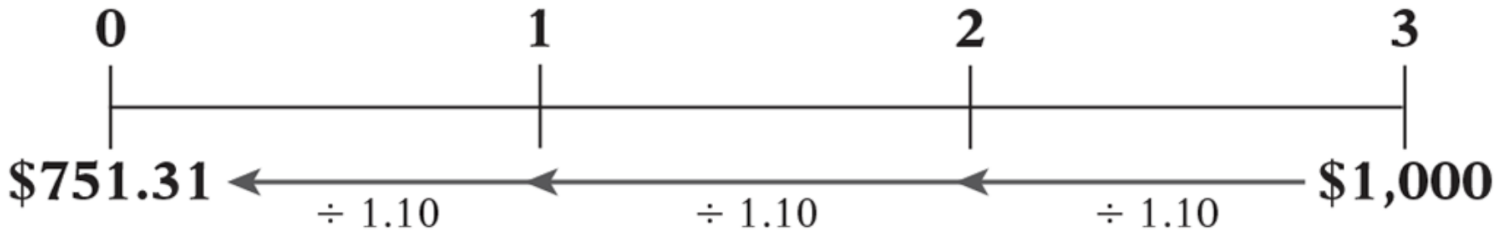
THE THREE RULES OF TIME TRAVEL: RULE 3 DISCOUNTING

Suppose the $1,000 were three years away:



In general, the present value (*PV*) of a cash flow *C* that comes *n* periods from now, we must discount it by the *n* intervening interest rate factors. If the per period interest rate *r* is constant, this yields:

$$PV = C \div (1 + r)^n = \frac{C}{(1 + r)^n}$$

4. Valuing cash flows at different points in time

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LECTURE EXAMPLE 2: QUESTION

Let's revisit Lecture Example 1 by comparing present values. You have a choice between receiving $5,000 today or $10,000 in five years. If the interest rate is 10% per year, calculate the present value of $10,000 received in five years. Which alternative do you prefer?

4. Valuing cash flows at different points in time

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LECTURE EXAMPLE 2: SOLUTION

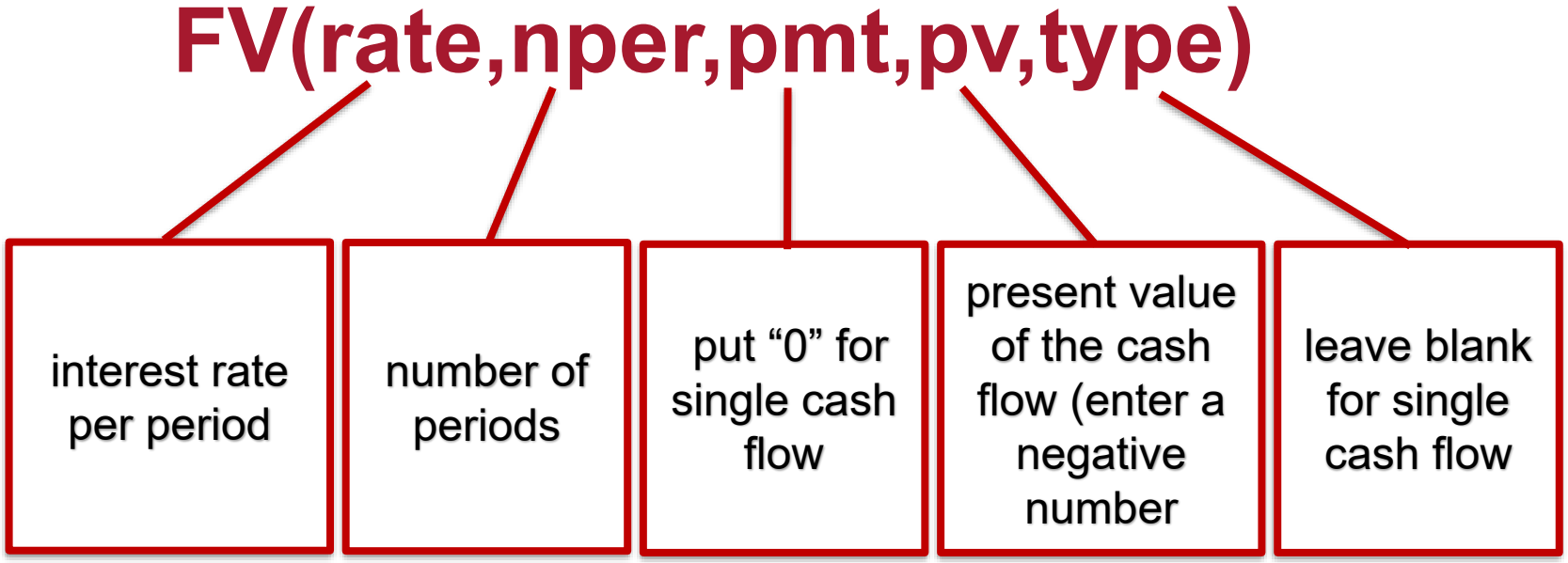
The present value of $10,000 received in five years when the interest rate is 10% per year is:

$$\frac{\$10{,}000}{1.10^5} = \$6{,}209.21$$

Once again, you would be better off forgoing the gift of $5,000 today and taking the $10,000 in five years.

5. Excel TVM functions

CALCULATING FUTURE VALUES IN EXCEL

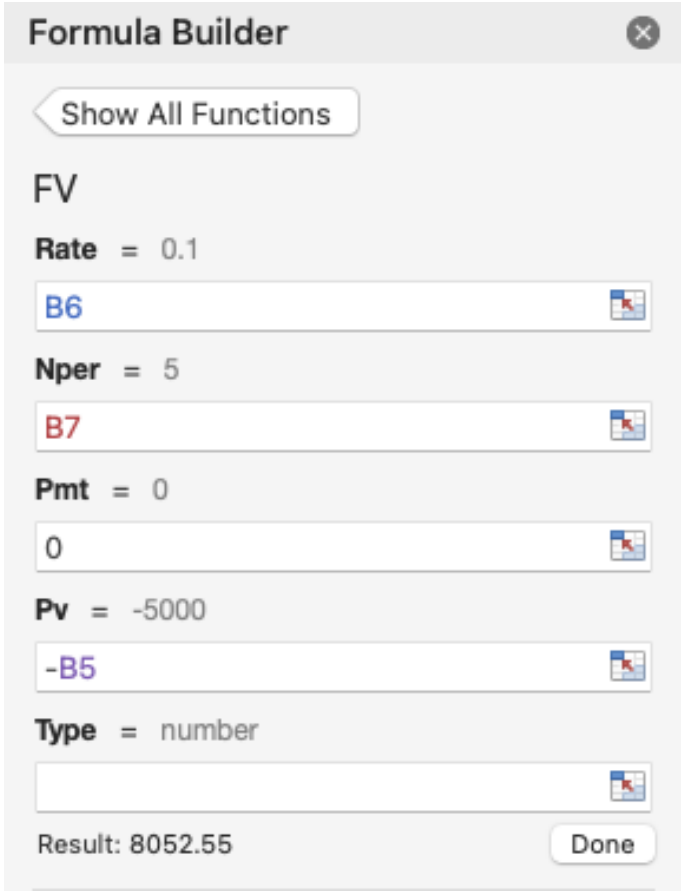


The **=FV()** function returns the future value of a single cash flow.

5. Excel TVM functions

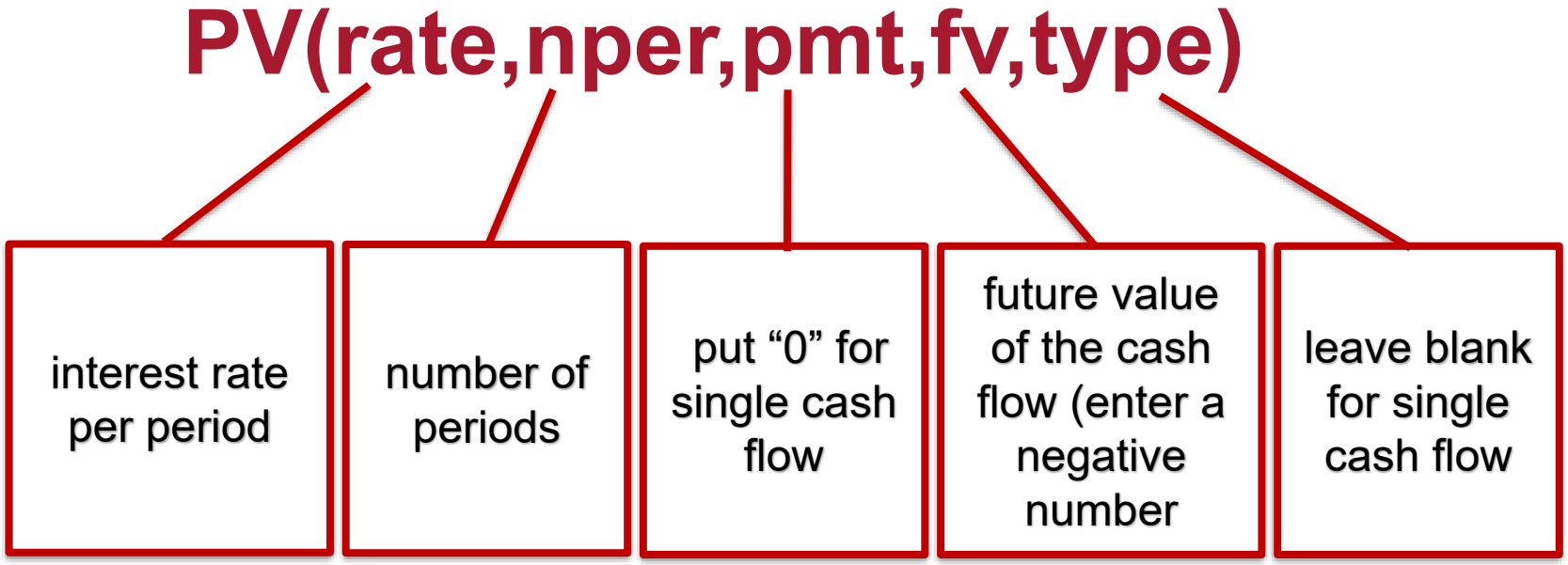
CALCULATING FUTURE VALUES IN EXCEL: REVISITING LECTURE EXAMPLE 1

	A	B	C
1	**Week 3 Lecture example 1**		
2			
3	What is the future value in 5 years of an initial investment of $5,000 at 10% per year?		
4			
5	Present value (PV)	$5,000.00	
6	Interest rate per year (*r*)	10%	
7	Number of periods in years (*n*)	5	
8			
9	**Using the formula for the future value**		
10	You need to enter	=B4*(1+B5)^B6	
11	Future value (FV)	$8,052.55	
12			
13	**Using the Excel future value function**		
14	You need to enter	=FV(B5,B6,0,-B4)	
15	Future value (FV)	$8,052.55	



5. Excel TVM functions

CALCULATING PRESENT VALUES IN EXCEL

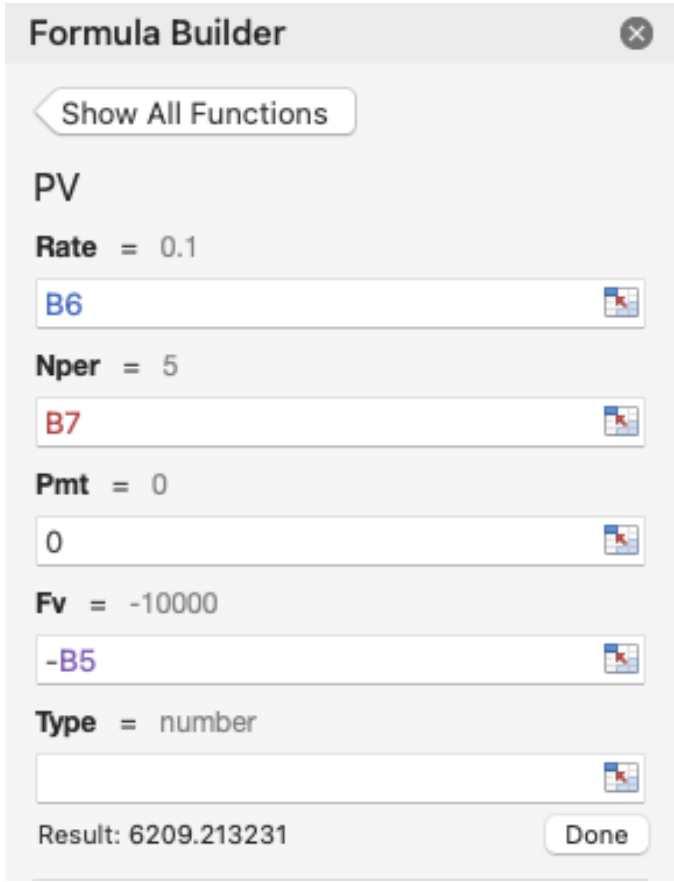


The **=PV()** function returns the present value of a single cash flow.

5. Excel TVM functions

CALCULATING PRESENT VALUES IN EXCEL: REVISITING LECTURE EXAMPLE 2

	A	B	C
1	**Week 3 Lecture example 2**		
2			
3	What is the present value in of $10,000 to be received in 5 years at 10% per year?		
4			
5	Future value (FV)	$10,000.00	
6	Interest rate per year (*r*)	10%	
7	Number of periods in years (*n*)	5	
8			
9	**Using the formula for the present value**		
10	You need to enter	=B4/(1+B5)^B6	
11	Present value (PV)	$6,209.21	
12			
13	**Using the Excel present value function**		
14	You need to enter	=FV(B5,B6,0,-B4)	
15	Present value (PV)	$6,209.21	



Summary

- Valuing decisions
  - Costs and benefits must be converted to common terms – cash today
- Market prices and valuation principle
  - Use market prices to determine the value of an asset
  - A decision increases wealth when the value of the benefits exceeds the costs
- The time value of money and interest rates
  - TVM, interest rate, present value, future value, timelines
- Valuing cash flows at different points in time
  - The three rules of time travel
- Excel TVM functions

Formula summary

Rule 1	Only values at the same point in time can be compared or combined.	
Rule 2	To move a cash flow forward in time, you must compound it.	Future value of a cash flow $FV_n = C \times (1+r)^n$
Rule 3	To move a cash flow backward in time, you must discount it.	Present value of a cash flow $PV = C \div (1+r)^n = \frac{C}{(1+r)^n}$